Maximizing Java Performance on Mac OS X

Session 625

Maximizing Java Performance on Mac OS X

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Java Runtime Technologies and Platform Classes
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Introduction

- Understand performance of your Java application
- Runtime improvements
  - HotSpot optimized for G5
- Performance opportunities in Java 1.4.1
  - Aggressive inlining
  - New I/O
- Graphics performance

Maximizing Java Performance

Java VM Changes

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Code Generation and Runtimes
jlaskey@apple.com

Overview

- Introduction to the G5
- Performance comparison G4 vs. G5
- Changes to the HotSpot Interpreter and JITc
- Changes to the HotSpot Runtime

Introduction to the G5

- G5 and Java developers
  - Faster CPU, bus, and floating-point
- G5 and the Java VM
  - VM uses G5 instruction set
  - 64-bit wins without the penalty of 64-bit addresses
- G5 and your Java application

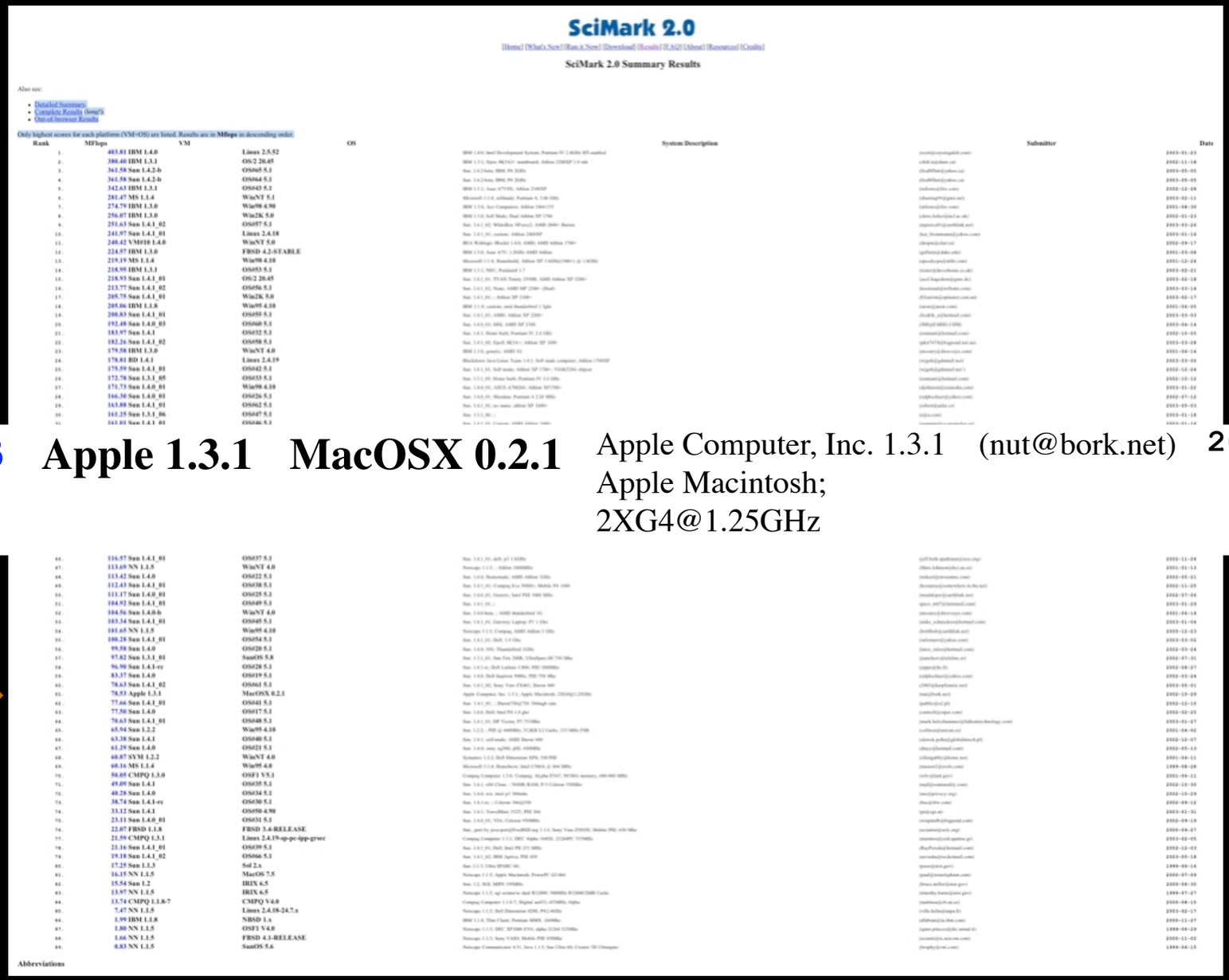
Performance Comparison G4 vs. G5

- Benchmarks
  - Internally we use SpecJVM, SciMark, Volano, and Caffeine
  - SpecJVM is best, but fair use requires public posting
  - SciMark is a decent benchmark with a focus on scientific/ engineering computation

Performance Comparison G4 vs. G5

SciMark 2.0

- http://math.nist.gov/cgi-bin/ScimarkSummary



SciMark 2.0

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SciMark 2.0 Summary Results

Also see:

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Only highest scores for each platform (VM+OS) are listed. Results are in **Mflops** in descending order.

Rank	Mflops	VM	OS	System Description	Submitter	Date
1.	403.81	IBM 1.4.0	Linux 2.5.52	IBM 1.4.0, Intel Development System, Pentium IV 2.1GHz HT-enabled	(scott@corporatejerk.com)	2003-01-23
2.	380.40	IBM 1.3.1	OS/2 20.45	IBM 1.3.1, Spec 8KHA2+ mainboard, Athlon 2100XP 1.8 mh	(chrh.ca@shaw.ca)	2002-11-14
3.	361.58	Sun 1.4.2-b	OS/66 5.1	Sun, 1.4.2-beta, IBM, P4 2GHz	(JoeIBMJoe@yahoo.ca)	2003-05-05
4.	361.58	Sun 1.4.2-b	OS/66 5.1	Sun, 1.4.2-beta, IBM, P4 2GHz	(JoeIBMJoe@yahoo.ca)	2003-05-05
5.	342.63	IBM 1.3.1	OS/43 5.1	IBM 1.3.1, Asus A7V8X, Athlon 2100XP	(nehrenc@fsu.com)	2002-12-28
6.	283.47	MS 1.1.4	WinNT 5.1	Microsoft 1.1.4, softmade, Pentium 4, 3.06 GHz	(cheating99@juno.net)	2003-02-13
7.	274.79	IBM 1.3.0	Win98 4.90	IBM 1.3.0, Ace Computers, Athlon 1466/333	(nehrenc@fsu.com)	2001-08-30
8.	256.07	IBM 1.3.0	Win2K 5.0	IBM 1.3.0, Self Made, Dual Athlon XP 1700	(chris.forkel@ncl.ac.uk)	2002-01-23
9.	251.63	Sun 1.4.1_02	OS/057 5.1	Sun, 1.4.1_02, WhiteBox 'nForce2', AMD 2000+ Barton	(mpiercel@yorkhtek.net)	2003-03-26
10.	241.97	Sun 1.4.1_01	Linux 2.4.18	Sun, 1.4.1_01, custom, Athlon 2400XP	(kai_brantmann@yhoo.com)	2003-01-14
11.	240.42	VM#10 1.4.0	WinNT 5.0	IBUK Weltlogic iBuckit 1.4.0, AMD, AMD Athlon 1700+	(dreppin@chat.ru)	2002-09-17
12.	224.57	IBM 1.3.0	FBSD 4.2-STABLE	IBM 1.3.0, Asus A7V, 1.2GHz AMD Athlon	(gollatin@duke.edu)	2001-03-08
13.	219.19	MS 1.1.4	Win98 4.10	Microsoft 1.1.4, Homebuild, Athlon XP 1.6GHz(1900+) @ 1.8GHz	(speedycpu@attbi.com)	2001-12-24
14.	218.95	IBM 1.3.1	OS/053 5.1	IBM 1.3.1, NEC, Pentium4 1.7	(tester@devonline.co.uk)	2003-02-21
15.	218.93	Sun 1.4.1_01	OS/2 20.45	Sun, 1.4.1_01, TT-ATi Trinity 256MB, AMD Athlon XP 2200+	(mcf.bagshaw@gmx.de)	2003-02-18
16.	213.77	Sun 1.4.1_02	OS/056 5.1	Sun, 1.4.1_02, Note, AMD MP 2200+ (Dual)	(fcurran@softhus.com)	2003-03-14
17.	205.75	Sun 1.4.1_01	Win2K 5.0	Sun, 1.4.1_01, -, Athlon XP 2100+	(Curran@optimizer.com.au)	2003-02-17
18.	205.06	IBM 1.3.0	Win95 4.10	IBM 1.3.0, custom, and thunderbird 3.5ghz	(anon@anon.com)	2001-04-05
19.	200.83	Sun 1.4.1_01	OS/058 5.1	Sun, 1.4.1_01, AMD, Athlon XP 2200+	(fredrik_s@hotmail.com)	2003-03-03
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25.	175.59	Sun 1.4.1_01	OS/042 5.1	Sun, 1.4.1_01, Self made, Athlon XP 1700+, 512MCT266 chipset	(vigabl@gdnmail.net')	2002-12-24
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28.	166.30	Sun 1.4.0_01	OS/026 5.1	Sun, 1.4.0_01, Mesidite, Pentium 4 2.26 MHz	(ralphschuet@yahoo.com)	2002-07-10
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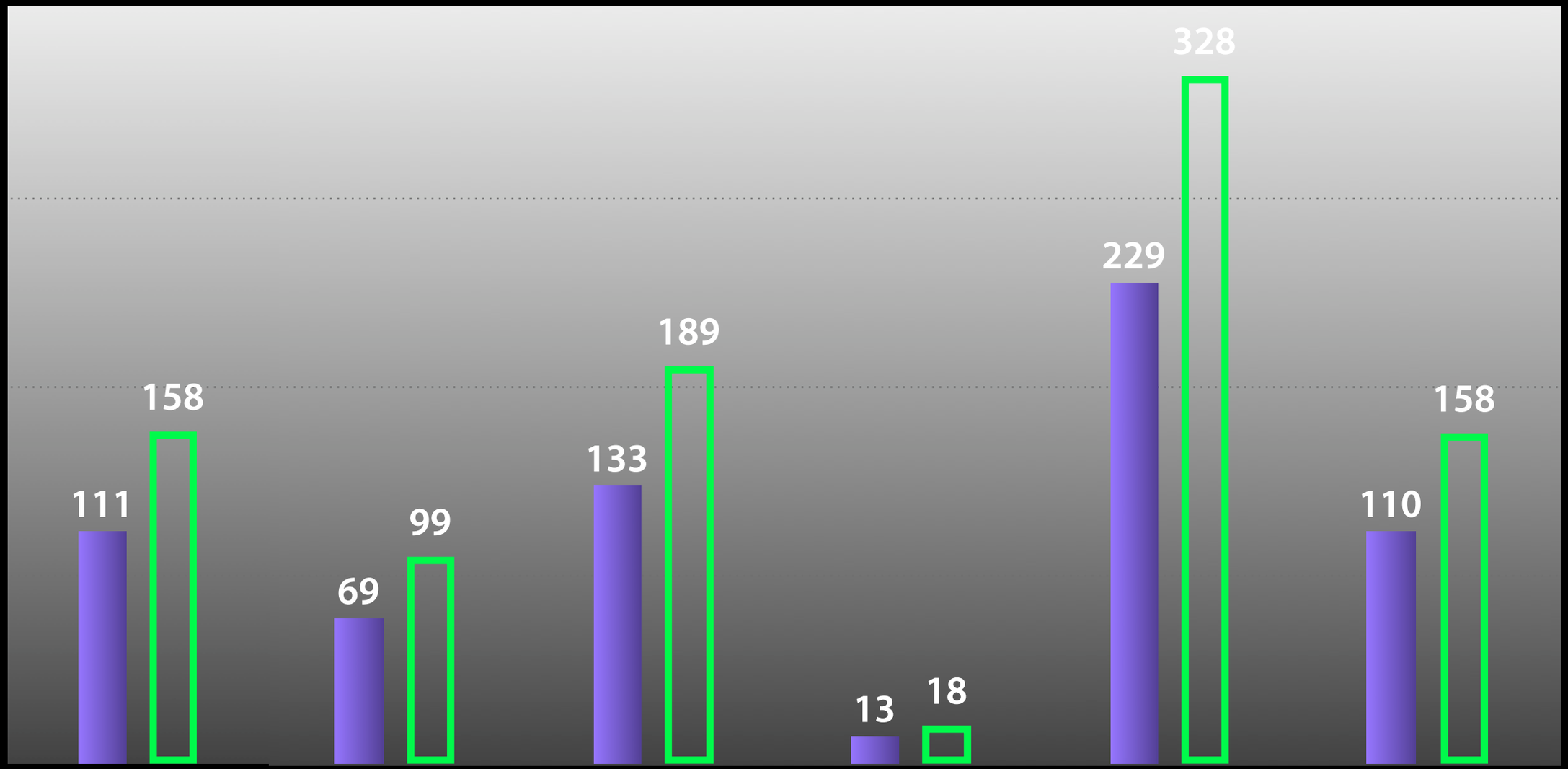
30.	161.25	Sun 1.3.1_06	OS/047 5.1	Sun, 1.3.1_06, -	(s@k.com)	2003-01-18
31.	161.01	Sun 1.4.1_01	OS/046 5.1	Sun, 1.4.1_01, Custom, AMD Athlon 1600+	(vonkunt@hotmail.com)	2003-01-14
61.	**78.53**	**Apple 1.3.1**	**MacOSX 0.2.1**	Apple Computer, Inc. 1.3.1 Apple Macintosh; 2XG4@1.25GHz	(nut@bork.net)	2002-10-29
62.	116.57	Sun 1.4.1_01	OS/037 5.1	Sun, 1.4.1_01, dell, p3 1.4GHz	(jeff.bork.sparkman@xxx.org)	2002-11-24
63.	113.69	NN 1.1.5	WinNT 4.0	Netscape 1.1.5, -, Athlon 1800MHz	(Marc.Johnson@ci.on.us)	2001-01-13
64.	113.42	Sun 1.4.0	OS/022 5.1	Sun, 1.4.0, Homemade, AMD Athlon 1GHz	(mikael@devonline.com)	2002-05-21
65.	112.43	Sun 1.4.1_01	OS/038 5.1	Sun, 1.4.1_01, Compaq Evo N800c, Mobile P4 1600	(hcouture@somewhere.in.the.net)	2002-11-05
66.	111.17	Sun 1.4.0_01	OS/025 5.1	Sun, 1.4.0_01, Generic, Intel PIII 1000 MHz	(mudshiper@earthlink.net)	2002-07-04
67.	104.92	Sun 1.4.1_01	OS/049 5.1	Sun, 1.4.1_01, -	(poco_m07@hotmail.com)	2003-01-29
68.	104.56	Sun 1.4.0-b	WinNT 4.0	Sun, 1.4.0-beta, -, AMD thunderbird 1G	(mcrary@dreezys.com)	2001-04-14
69.	103.34	Sun 1.4.1_01	OS/045 5.1	Sun, 1.4.1_01, Gateway Laptop, P1 1 Ghz	(mike_schneider@hotmail.com)	2003-01-04
70.	101.65	NN 1.1.5	Win95 4.10	Netscape 1.1.5, Compaq, AMD Athlon 1 GHz	(bottlbob@earthlink.net)	2003-12-23
71.	100.28	Sun 1.4.1_01	OS/054 5.1	Sun, 1.4.1_01, Dell, 3.9 Ghz	(nehrenc@yahoo.com)	2003-03-02
72.	99.58	Sun 1.4.0	OS/020 5.1	Sun, 1.4.0, NN, Thunderbird 1GHz	(latex_ruler@hotmail.com)	2002-03-24
73.	97.82	Sun 1.3.1_01	SunOS 5.8	Sun, 1.3.1_01, Sun Ftw 360R, UltraSparc-II 750 Mhz	(jsanchez@sdsbbs.ca)	2002-07-31
74.	96.90	Sun 1.4.1-rc	OS/028 5.1	Sun, 1.4.1-rc, Dell Latitude C600, PIII 1000Mhz	(cpgt@ikc.fi)	2002-08-27
75.	83.37	Sun 1.4.0	OS/019 5.1	Sun, 1.4.0, Dell Inspiron 5000e, PIII 750 Mhz	(ralphschuet@yahoo.com)	2002-03-24
76.	78.63	Sun 1.4.1_02	OS/061 5.1	Sun, 1.4.1_02, Sony Vaio FX401, Duron 800	(2005@keepforever.net)	2003-05-01
77.	78.53	Apple 1.3.1	MacOSX 0.2.1	Apple Computer, Inc. 1.3.1, Apple Macintosh, 2XG4@1.25GHz	(nut@bork.net)	2002-10-29
78.	77.66	Sun 1.4.1_01	OS/040 5.1	Sun, 1.4.1_01, -, Duron750@750 366mgb ram	(pablo@cpl.ch)	2002-12-10
79.	77.50	Sun 1.4.0	OS/017 5.1	Sun, 1.4.0, Dell, Intel P4 1.4 ghz	(cantor@caspar.com)	2002-02-25
80.	70.63	Sun 1.4.1_01	OS/048 5.1	Sun, 1.4.1_01, HP Vectra, P3 733Mhz	(mark.kolhammer@fabmatics.hecksgy.com)	2003-01-27
81.	65.94	Sun 1.2.2	Win95 4.10	Sun, 1.2.2, -, PIII @ 666MHz, 512KB L2 Cache, 133 MHz FSB	(collins@unicon.ca)	2001-04-02
82.	63.38	Sun 1.4.1	OS/040 5.1	Sun, 1.4.1, self-made, AMD Duron 800	(derek.pelkie@globalmech.pf)	2002-12-07
83.	61.29	Sun 1.4.0	OS/021 5.1	Sun, 1.4.0, sony xg500, p6H, 450MHz	(dhyo@hotmail.com)	2002-05-13
84.	60.87	SVM 1.2.2	WinNT 4.0	Symantec 1.2.2, Dell Dimension XPS, 550 PIII	(vfrag@fly.cybertec.net)	2001-04-11
85.	60.16	MS 1.1.4	Win95 4.0	Microsoft 1.1.4, Homebrew, Intel C700A @ 466 MHz	(mason2@corth.com)	1999-08-28
86.	50.05	CMPQ 1.3.0	OSF1 V5.1	Compaq Computer 1.3.0, Compaq, Alpha EV67, 90 MA memory, 600-900 MHz	(wlv@dnf.gov)	2001-05-11
87.	49.09	Sun 1.4.1	OS/035 5.1	Sun, 1.4.1, x86 Clone - 384Mb RAM, P-3 Celeron 550Mhz	(mpl@commodity.com)	2002-10-30
88.	40.28	Sun 1.4.0	OS/034 5.1	Sun, 1.4.0, x/c, intel p3 700mhz	(mc@privacy.org)	2002-10-29
89.	38.74	Sun 1.4.1-rc	OS/030 5.1	Sun, 1.4.1-rc, -, Celeron 366@550	(bsc@ibx.com)	2002-09-12
90.	33.12	Sun 1.4.1	OS/050 4.90	Sun, 1.4.1, TransMeta 5535, PIII 366	(pcl@cgs.nl)	2003-01-31
91.	23.11	Sun 1.4.0_01	OS/031 5.1	Sun, 1.4.0_01, VIA, Celeron 950MHz	(wiapatch@biggend.com)	2002-09-19
92.	22.07	FBSD 1.1.8	FBSD 3.4-RELEASE	Sun, port by java-port@FreeBSD.org 1.1.8, Sony Vaio Z505JS, Mobile P3E, 650 Mhz	(scranton@ucls.org)	2000-09-27
93.	21.59	CMPQ 1.3.1	Linux 2.4.19-sp-pc-ipp-grsec	Compaq Computer 1.3.1, DEC Alpha 164SX, 21264PC 550MHz	(martinez@cold.spartus.gr)	2003-02-05
94.	21.16	Sun 1.4.1_01	OS/039 5.1	Sun, 1.4.1_01, Dell, Intel PII 251 MHz	(RayPowder@hotmail.com)	2002-12-03
95.	19.18	Sun 1.4.1_02	OS/066 5.1	Sun, 1.4.1_02, IBM Aptiva, PIII 450	(mrcrabe@cox.hotmail.com)	2003-05-14
96.	17.25	Sun 1.3.3	Sol 2.x	Sun, 1.3.3, Ultra SPARC 60,	(jmast@mit.gov)	1999-04-14
97.	16.15	NN 1.1.5	MacOS 7.5	Netscape 1.1.5, Apple Macintosh, PowerPC G3 466	(paul@roanokphant.com)	2000-07-04
98.	15.54	Sun 1.2	IRIX 6.5	Sun, 1.2, SGI, MIPS 195MHz	(bruce.miller@mit.gov)	2000-04-30
99.	13.97	NN 1.1.5	IRIX 6.5	Netscape 1.1.5, sgi octane/oe dual R12000, 300MHz R12000/2MB Cache	(timothy.hume@mit.gov)	1999-07-27
100.	13.74	CMPQ 1.1.8-7	CMPQ V4.0	Compaq Computer 1.1.8-7, Digital au4351, 433MHz Alpha	(matthias@cfr.de.us)	2000-04-15
101.	7.47	NN 1.1.5	Linux 2.4.18-24.7.x	Netscape 1.1.5, Dell Dimension X295, P4/2.4GHz	(villa.helm@mapo.fr)	2003-02-17
102.	1.99	IBM 1.1.8	NBSD 1.x	IBM 1.1.8, Thin Client, Pentium MMX -266Mhz	(dfabian@in.ibm.com)	2000-11-07
103.	1.80	NN 1.1.5	OSF1 V4.0	Netscape 1.1.5, DEC XP1000 EV6, alpha 21264 525Mhz	(john.prisco@dec.nmsd.it)	1999-04-29
104.	1.66	NN 1.1.5	FBSD 4.1-RELEASE	Netscape 1.1.5, Sony VAIO, Mobile PIII 450Mhz	(scranit@ix.netcom.com)	2000-12-02
105.	0.83	NN 1.1.5	SunOS 5.6	Netscape Communicator 4.51, Java 1.1.5, Sun Ultra 60, Creator 3D Elite	(bopby@vnt.com)	1999-04-15

Abbreviations

Performance Comparison G4 vs. G5

SciMark on HotSpot Client



Performance Comparison G4 vs. G5

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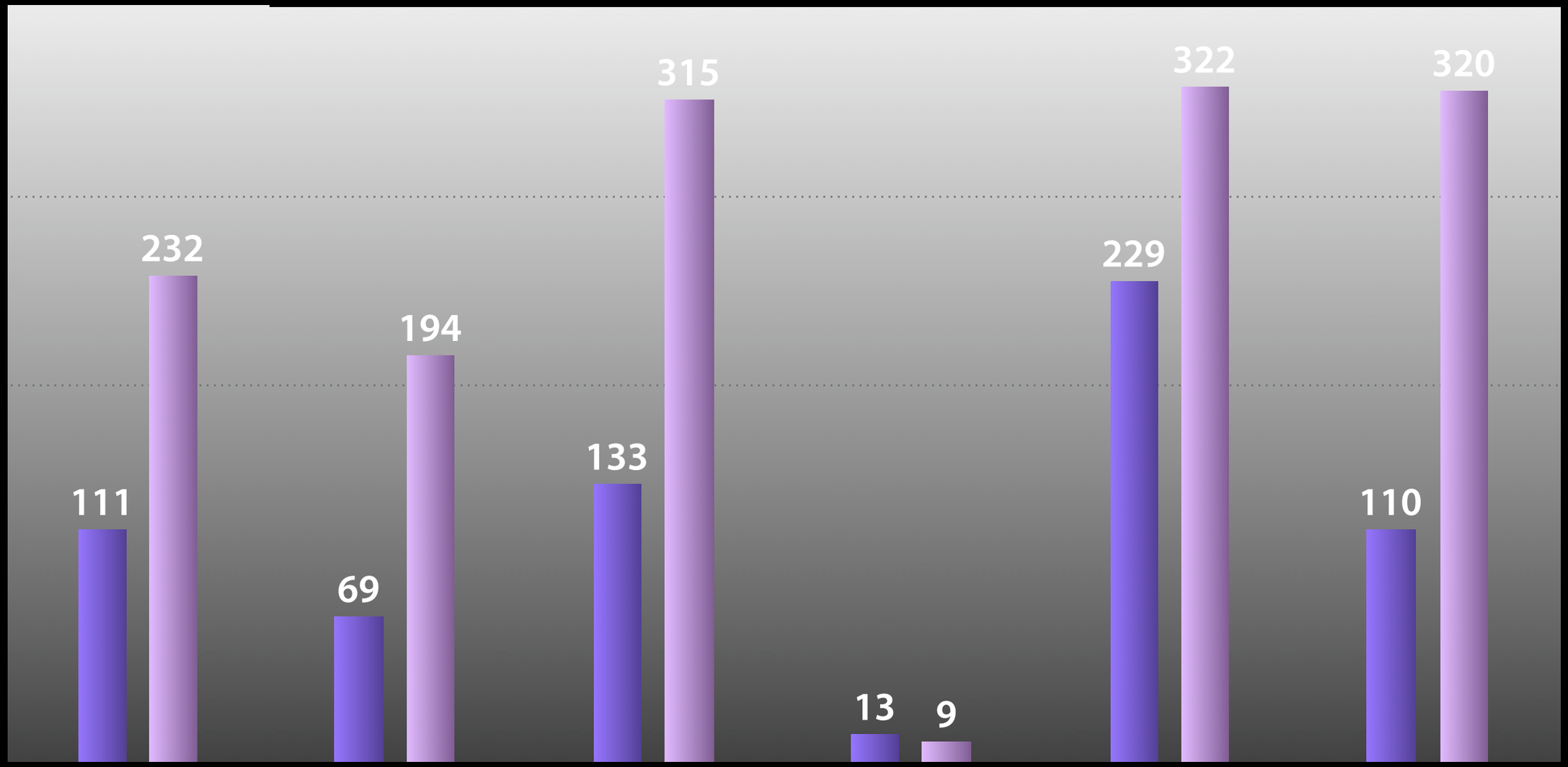

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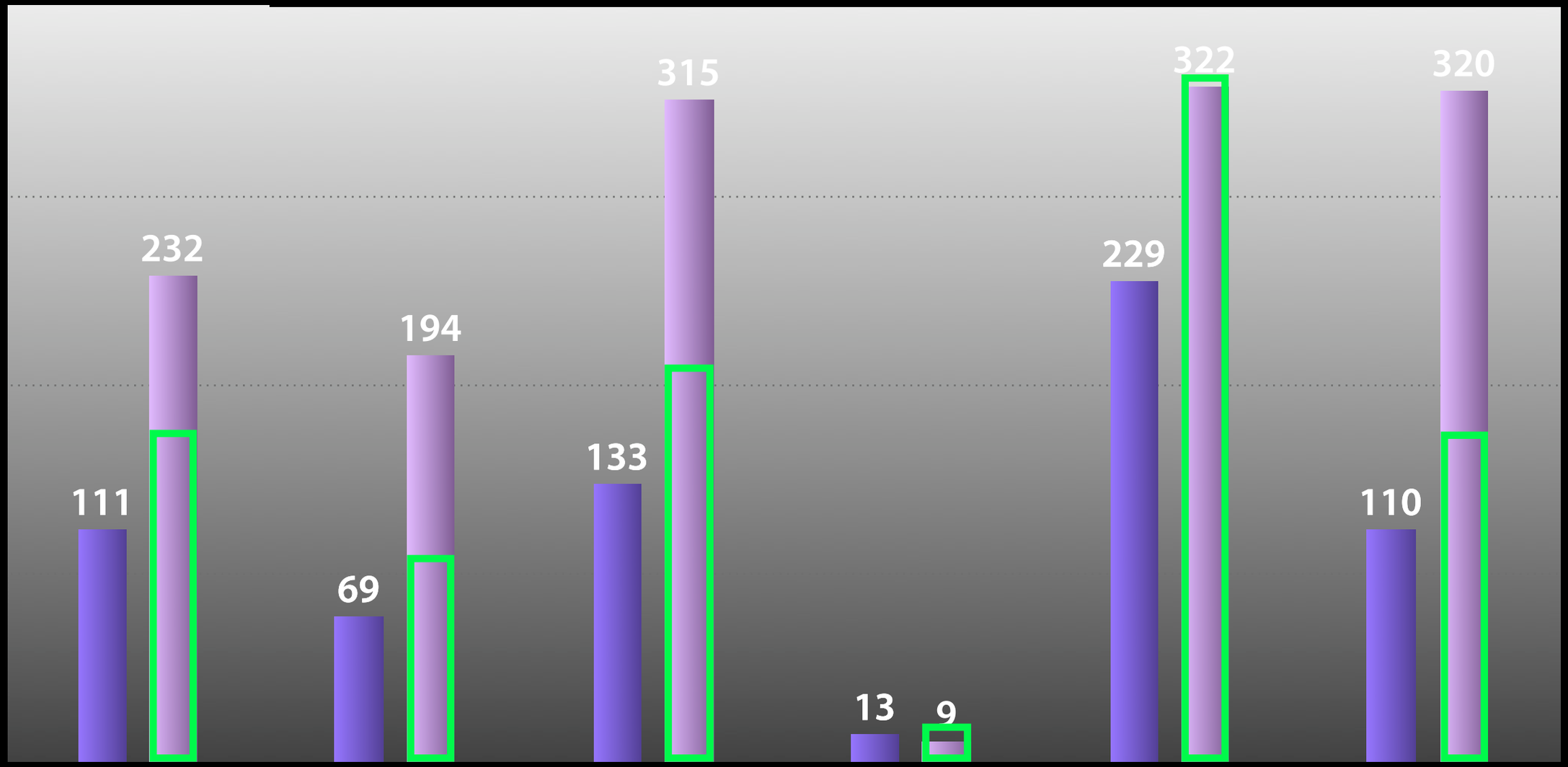

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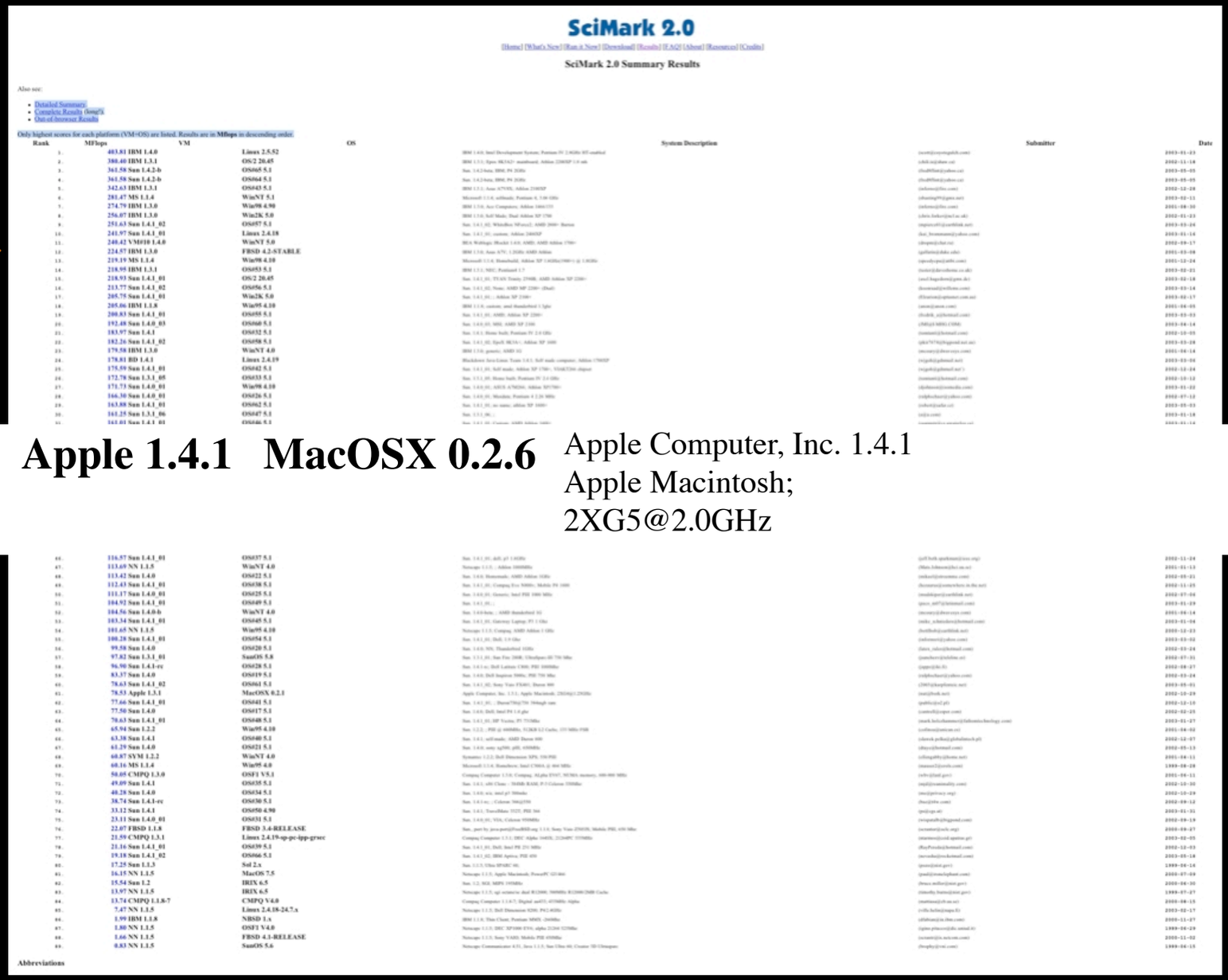

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3.	361.58	Sun 1.4.2-b	OS/664 5.1	Sun, 1.4.2-beta, IBM, P4 2GHz	(DonBNunn@yahoo.ca)	2003-05-05
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32.	231.84	Apple 1.4.1	MacOSX 0.2.6	Apple Computer, Inc. 1.4.1, Apple Macintosh, 2XG5@2.0GHz	(scott@corporatejerk.com)	2003-6-27
33.	116.57	Sun 1.4.1_01	OS/037 5.1	Sun, 1.4.1_01, dell, p3 1.4GHz	(jeff.bolt.sparkman@xxx.org)	2002-11-24
34.	113.69	NN 1.1.5	WinNT 4.0	Netscape 1.1.5, -, Athlon 1800MHz	(Marc.Johnson@ci.on.us)	2001-01-13
35.	113.42	Sun 1.4.0	OS/022 5.1	Sun, 1.4.0, Homemade, AMD Athlon 1GHz	(mikael@dvtcomm.com)	2002-05-21
36.	112.43	Sun 1.4.1_01	OS/038 5.1	Sun, 1.4.1_01, Compaq Evo N800c, Mobile P4 1600	(hcouture@somewhere.in.the.net)	2002-11-05
37.	111.17	Sun 1.4.0_01	OS/025 5.1	Sun, 1.4.0_01, Generic, Intel P3E 1000 MHz	(mudskipr@earthlink.net)	2002-07-04
38.	104.92	Sun 1.4.1_01	OS/049 5.1	Sun, 1.4.1_01, -	(pico_m07@hotmail.com)	2003-01-29
39.	104.56	Sun 1.4.0-b	WinNT 4.0	Sun, 1.4.0-beta, -, AMD thunderbird 1G	(mcrary@dnsrsys.com)	2001-04-14
40.	103.34	Sun 1.4.1_01	OS/045 5.1	Sun, 1.4.1_01, Gateway Laptop, P1 1 Ghz	(mike_schneider@hotmail.com)	2003-01-04
41.	101.65	NN 1.1.5	Win95 4.10	Netscape 1.1.5, Compaq, AMD Athlon 1 GHz	(bottlbob@earthlink.net)	2003-12-23
42.	100.28	Sun 1.4.1_01	OS/054 5.1	Sun, 1.4.1_01, Dell, 3.0 Ghz	(nfortner@yahoo.com)	2003-03-02
43.	99.58	Sun 1.4.0	OS/020 5.1	Sun, 1.4.0, NN, Thunderbird 1GHz	(latex_ruler@hotmail.com)	2002-03-24
44.	97.82	Sun 1.3.1_01	SunOS 5.8	Sun, 1.3.1_01, Sun Fire 280R, UltraSparc-III 750 Mhz	(jsanchez@solidtw.co)	2002-07-31
45.	96.90	Sun 1.4.1-rc	OS/028 5.1	Sun, 1.4.1-rc, Dell Latitude C800, P3E 1000Mhz	(cpp@dkr.fi)	2002-08-27
46.	83.37	Sun 1.4.0	OS/019 5.1	Sun, 1.4.0, Dell Inspiron 5000e, P3E 750 Mhz	(ralphschuler@yahoo.com)	2002-03-24
47.	78.63	Sun 1.4.1_02	OS/061 5.1	Sun, 1.4.1_02, Sony Vaio FX401, Duron 800	(2005@keepforever.net)	2003-05-01
48.	78.53	Apple 1.3.1	MacOSX 0.2.1	Apple Computer, Inc. 1.3.1, Apple Macintosh, 2XG4@1.25GHz	(mat@bolt.net)	2002-10-29
49.	77.66	Sun 1.4.1_01	OS/041 5.1	Sun, 1.4.1_01, -, Duron750@750 566mph rate	(pablo@cpl.ch)	2002-12-10
50.	77.50	Sun 1.4.0	OS/017 5.1	Sun, 1.4.0, Dell, Intel P4 1.4 ghz	(cotrell@capat.com)	2002-02-25
51.	70.63	Sun 1.4.1_01	OS/048 5.1	Sun, 1.4.1_01, HP Vectra, P1 733Mhz	(mark.hutchinson@fabmatrixtechnology.com)	2003-01-27
52.	65.94	Sun 1.2.2	Win95 4.10	Sun, 1.2.2, , P3E @ 666MHz, 512KB L2 Cache, 133 MHz FSB	(collins@unicon.ca)	2001-04-02
53.	63.38	Sun 1.4.1	OS/040 5.1	Sun, 1.4.1, self-made, AMD Duron 800	(derek.pulko@globalintech.pl)	2002-12-07
54.	61.29	Sun 1.4.0	OS/021 5.1	Sun, 1.4.0, sony xg500, p6H, 450MHz	(dhays@hotmail.com)	2002-05-13
55.	60.87	SYM 1.2.2	WinNT 4.0	Symantec 1.2.2, Dell Dimension XPS, 550 PIII	(cflaig@fly.cybertec.net)	2001-04-11
56.	60.16	MS 1.1.4	Win95 4.0	Microsoft 1.1.4, Homebrew, Intel C700A @ 466 MHz	(mason2@corrib.com)	1999-08-28
57.	50.05	CMPQ 1.3.0	OSF1 V5.1	Compaq Computer 1.3.0, Compaq, Alpha EV67, 667MA memory, 600-900 MHz	(wlv@dnf.gov)	2001-06-11
58.	49.09	Sun 1.4.1	OS/035 5.1	Sun, 1.4.1, x86 Clone - 384Mb RAM, P-3 Celeron 550Mhz	(mpl@commodity.com)	2002-10-30
59.	40.28	Sun 1.4.0	OS/034 5.1	Sun, 1.4.0, n/a, intel p3 700mhz	(mc@privacy.org)	2002-10-29
60.	38.74	Sun 1.4.1-rc	OS/030 5.1	Sun, 1.4.1-rc, - Celeron 366@550	(bsc@bbn.com)	2002-09-12
61.	33.12	Sun 1.4.1	OS/050 4.90	Sun, 1.4.1, TransMeta 5535, PIII 366	(pa@cgs.at)	2003-01-31
62.	23.11	Sun 1.4.0_01	OS/031 5.1	Sun, 1.4.0_01, VIA, Celeron 950MHz	(wiapatah@biggend.com)	2002-09-19
63.	22.07	FBSD 1.1.8	FBSD 3.4-RELEASE	Sun, part by java-port@FreeBSD.org 1.1.8, Sony Vaio Z505JS, Mobile P3E, 650 Mhz	(scranton@ucls.org)	2000-09-27
64.	21.59	CMPQ 1.3.1	Linux 2.4.19-sp-pc-ipp-grsec	Compaq Computer 1.3.1, DEC Alpha 164SX, 21264PC 575Mhz	(martinez@cool.upatras.gr)	2003-02-05
65.	21.16	Sun 1.4.1_01	OS/039 5.1	Sun, 1.4.1_01, Dell, Intel P4 231 MHz	(RayPowder@hotmail.com)	2002-12-03
66.	19.18	Sun 1.4.1_02	OS/066 5.1	Sun, 1.4.1_02, IBM Aptiva, P3E 450	(mrcrabb@cs.hotmail.com)	2003-05-14
67.	17.25	Sun 1.3.3	Sol 2.x	Sun, 1.3.3, Ultra SPARC 60,	(pasat@nist.gov)	1999-04-14
68.	16.15	NN 1.1.5	MacOS 7.5	Netscape 1.1.5, Apple Macintosh, PowerPC G3 466	(paul@roanokphant.com)	2000-07-04
69.	15.54	Sun 1.2	IRIX 6.5	Sun, 1.2, SGI, MIPS 195MHz	(bruce.miller@nist.gov)	2000-04-30
70.	13.97	NN 1.1.5	IRIX 6.5	Netscape 1.1.5, sgi octane/oe dual R12000, 300MHz R12000/2MB Cache	(timothy.hunter@nist.gov)	1999-07-27
71.	13.74	CMPQ 1.1.8-7	CMPQ V4.0	Compaq Computer 1.1.8-7, Digital au4351, 433MHz Alpha	(mattman@cfr.ab.ca)	2000-04-15
72.	7.47	NN 1.1.5	Linux 2.4.18-24.7.x	Netscape 1.1.5, Dell Dimension XPS, P4/2.4GHz	(villa.helm@mapo.fi)	2003-02-17
73.	1.99	IBM 1.1.8	NBSD 1.x	IBM 1.1.8, Thin Client, Pentium MMX -266Mhz	(dfabian@in.ibm.com)	2000-11-27
74.	1.80	NN 1.1.5	OSF1 V4.0	Netscape 1.1.5, DEC XP1000 EV6, alpha 21264 525Mhz	(john.prisco@dec.nmsd.it)	1999-04-29
75.	1.66	NN 1.1.5	FBSD 4.1-RELEASE	Netscape 1.1.5, Sony VAIO, Mobile P3E 450Mhz	(scranton@ix.netcom.com)	2000-12-02
76.	0.83	NN 1.1.5	SunOS 5.6	Netscape Communicator 4.51, Java 1.1.5, Sun Ultra 60, Creator 3D Elite	(bwpby@vsnl.com)	1999-04-15

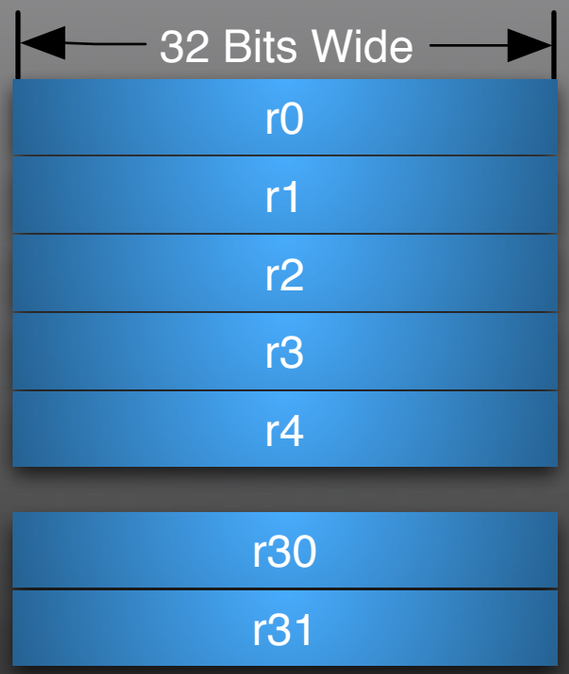
Abbreviations

Interpreter/JITc Changes

- Interpreter and JITc are enhanced with G5 instructions
- Java long support is improved using 64-bit instructions
- Float and double support is improved using new G5 floating point instructions

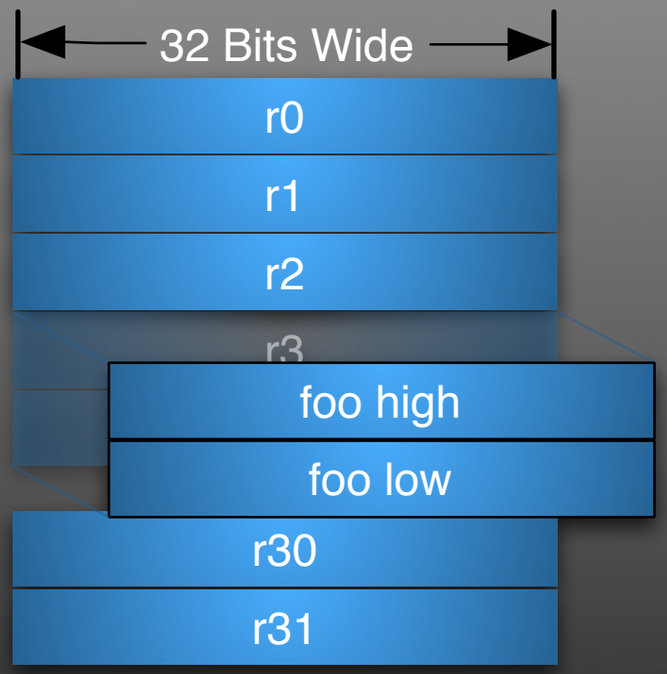
Interpreter/JITc Changes—Long

G4 General Purpose Registers



Interpreter/JITc Changes—Long

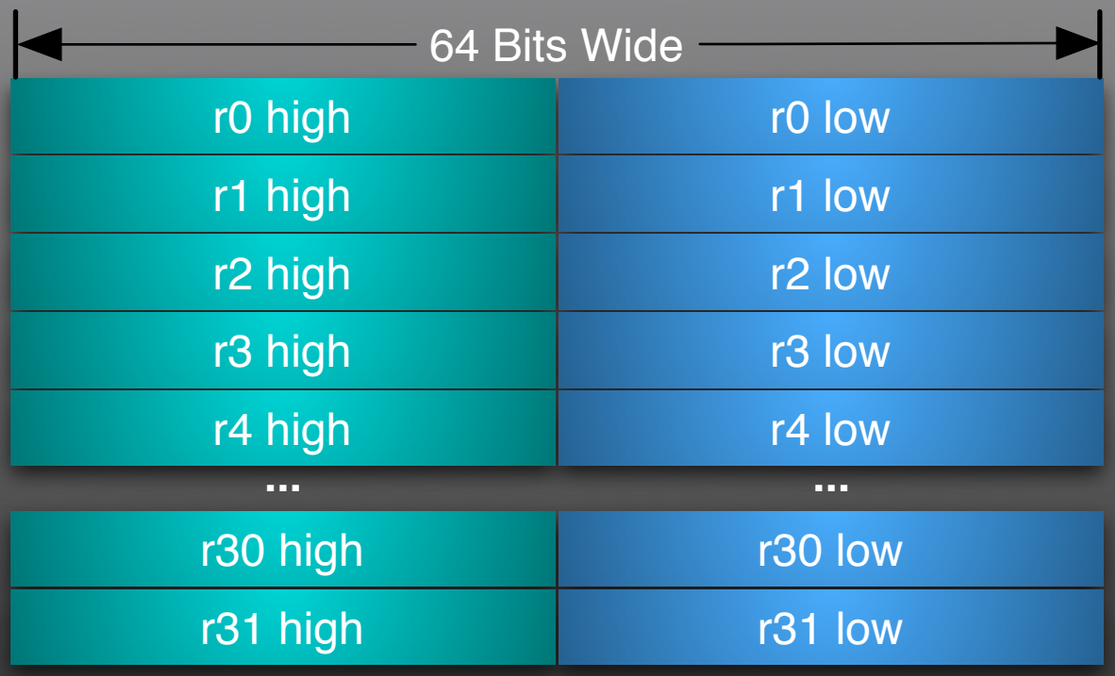
G4 General Purpose Registers




```
long foo;
foo = x + y;
```

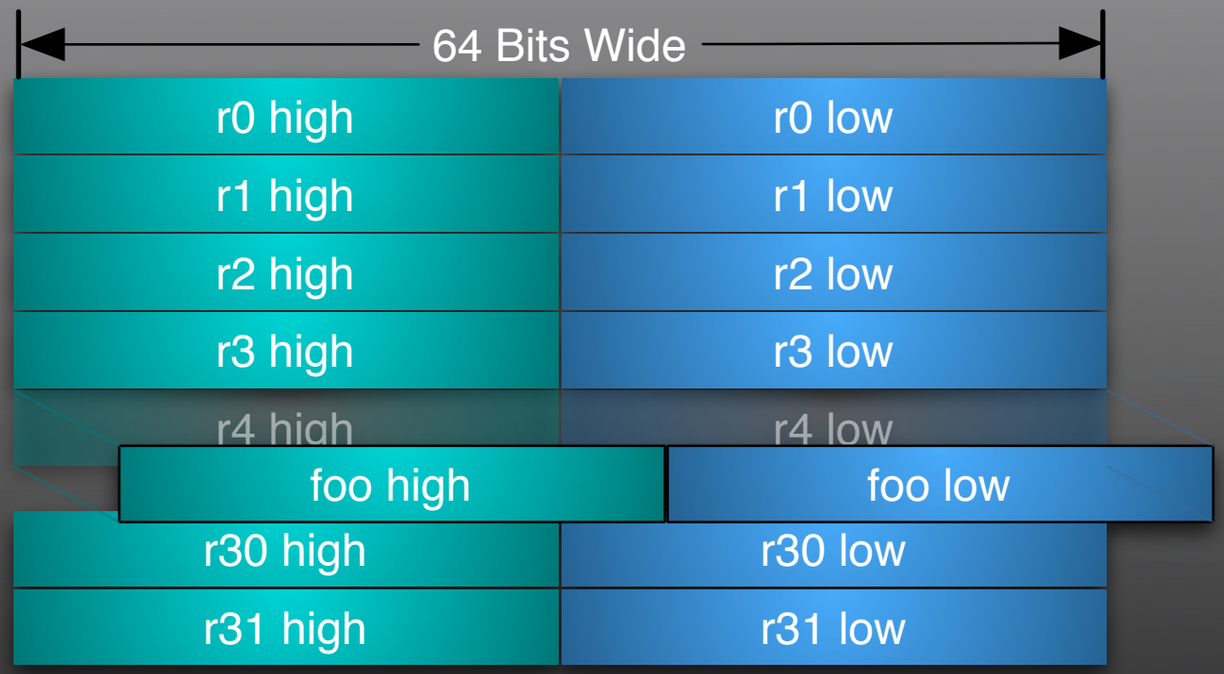
Interpreter/JITc Changes—Long

G5 General Purpose Registers



Interpreter/JITc Changes—Long

G5 General Purpose Registers




```
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foo = x + y;
```

Interpreter/JITc Changes—Long

- Single instruction loads and stores of longs

Interpreter/JITc Changes—Long

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```
long x = y;
```

Interpreter/JITc Changes—Long

- Single instruction loads and stores of longs

```
                        long x = y;
     G4

lwz     r3,y
lwz     r4,y+4
stw     r3,x
stw     r4,x+4
```

Interpreter/JITc Changes—Long

- Single instruction loads and stores of longs

```
long x = y;
```

G4

```
lwz     r3,y
lwz     r4,y+4
stw     r3,x
stw     r4,x+4
```

G5

```
ld      r3,y
std     r3,x
```

Interpreter/JITc Changes—Long

- Add, subtract, negate, and, or, xor (not)
  - Single instructions instead of two

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long z = x + y;
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Interpreter/JITc Changes—Long

- Add, subtract, negate, and, or, xor (not)
  - Single instructions instead of two

```
                        long z = x + y;
```

G4

```
lwz     r3,x
lwz     r4,x+4
lwz     r5,y
lwz     r6,y+4
addc    r8,r4,r6
adde    r7,r3,r5
stw     r7,z
stw     r8,z+4
```

Interpreter/JITc Changes—Long

- Add, subtract, negate, and, or, xor (not)
  - Single instructions instead of two

```
long z = x + y;
```

G4

```
lwz     r3,x
lwz     r4,x+4
lwz     r5,y
lwz     r6,y+4
addc    r8,r4,r6
adde    r7,r3,r5
stw     r7,z
stw     r8,z+4
```

G5

```
ld      r3,x
ld      r4,y
add     r5,r3,r4
std     r5,x
```

Interpreter/JITc Changes—Long

- Multiply, divide, remainder, shifts, comparisons
  - Single instructions instead of many or runtime call

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```
long z = x * y;
```

Interpreter/JITc Changes—Long

- Multiply, divide, remainder, shifts, comparisons
  - Single instructions instead of many or runtime call

```
                    long z = x * y;
      G4

lwz     r3,x
lwz     r4,x+4
lwz     r5,y
lwz     r6,y+4
mullw   r9,r3,r6
mulhwu  r10,r4,r6
add     r9,r9,r10
mullw   r10,r4,r5
mullw   r7,r4,r6
add     r8,r9,r10
stw     r7,z
stw     r8,z+4
```

Interpreter/JITc Changes—Long

- Multiply, divide, remainder, shifts, comparisons
  - Single instructions instead of many or runtime call

```
long z = x * y;
```

G4

```
lwz     r3,x
lwz     r4,x+4
lwz     r5,y
lwz     r6,y+4
mullw   r9,r3,r6
mulhwu  r10,r4,r6
add     r9,r9,r10
mullw   r10,r4,r5
mullw   r7,r4,r6
add     r8,r9,r10
stw     r7,z
stw     r8,z+4
```

G5

```
ld      r3,x
ld      r4,y
mulld   r5,r3,r4
std     r5,x
```

Interpreter/JITc Changed—Float

- Casts to/from long are now done inline
- Float/Double bit extractions (eg. doubleToLongBits) are now done inline
- Square root

Interpreter/JITc Changed—Float

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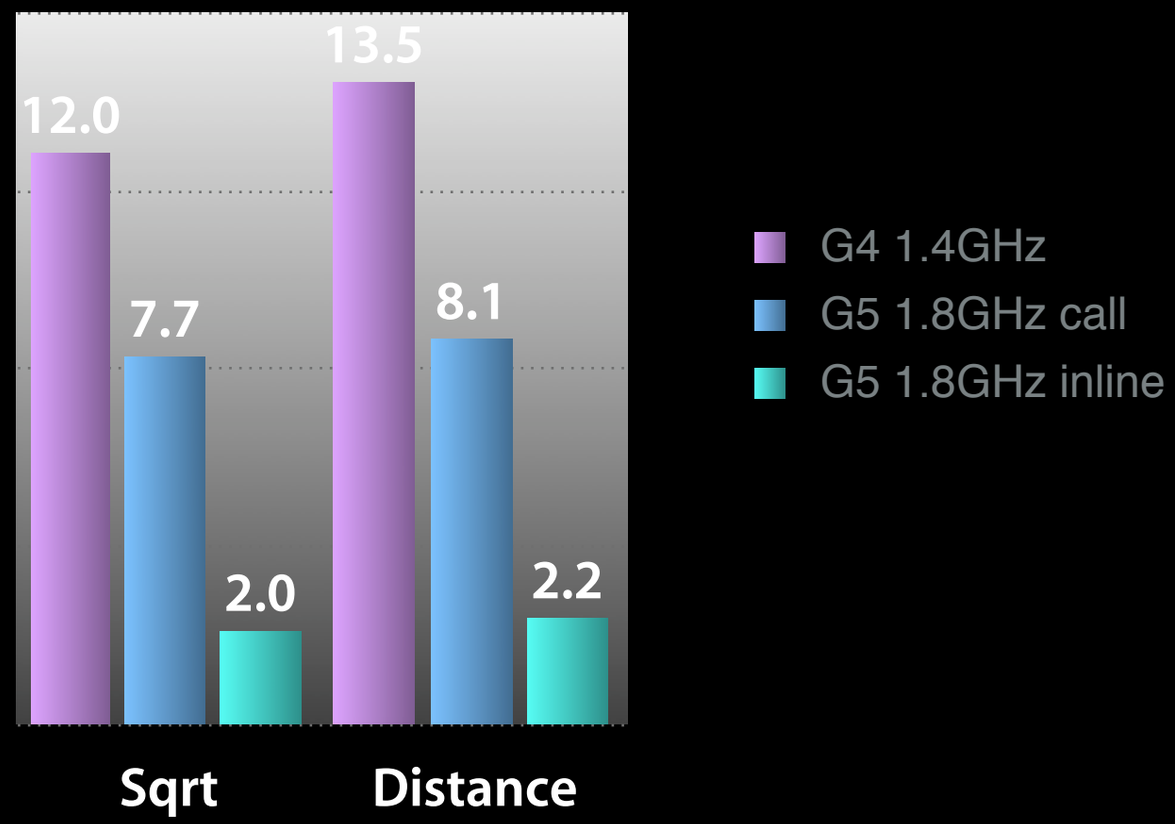
Library call versus inline fsqrt
100,000,000 data points
(Time in seconds)



Runtime Changes

- Volatile loads and stores
  - Using the `volatile` keyword on a field or static
  - Requires coordination of the low and high 32-bits
  - On the G4 we did a shuffle through a double register
  - On the G5 single instruction load or store

Runtime Changes

- Thread synchronization for memory allocation and monitors on dual processor machines use a new lightweight sync instruction (`lwsync`)
  - Doesn't require full disruption of the hardware state

Runtime Changes

- Atomic compare and exchange
  - sun.misc.AtomicLongCSImpl.attemptUpdate
  - Primarily used is in net operations
  - Multiprocessor access of long values
  - G4 uses Java synchronization
  - G5 uses lightweight load and reserve sequence

Summary

- Java 1.4.1 automatically adapts to the G5
- Significant performance wins across the board
  - Especially for long and floating point
- No java code changes required

Maximizing Java Performance

Optimal Java for Mac OS X

Victor Hernandez

Java Runtime Technologies

vhernandez@apple.com

Introduction

- HotSpot optimizes your application
  - Aggressive inlining in 1.4.1
- You can improve performance yourself
  - New I/O (NIO) in JDK 1.4.1
- Conclusions for optimizing heavily-used methods

Optimizing Java 1.4.1

- Situation:
  - A large cost of Java execution is the overhead of method invocation

- Approach:
  - Inline method calls during dynamic compilation

JIT Compilation: Inlining

- What is inlining?

```
int average(int a, int b) {
   int s = sum(a, b);
   return s / 2;
}

int sum(int x, int y) {
   return x + y;
}
```

```
int average(int a, int b) {
   int s = a + b;
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}
```

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- 1.3.1 inlining:
  - accessors/new/intrinsics (sin, cos, ...)
  - no virtual methods

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}
```

- 1.3.1 inlining:
  - accessors/new/intrinsics (sin, cos, ...)
  - no virtual methods
- How could we inline your virtual methods?

JIT Compilation: Aggressive Inlining

- Class Hierarchy Analysis (CHA):
  - monomorphic: Only one implementation of a virtual method has been loaded
- HotSpot 1.4.1 aggressively inlines monomorphic methods
- Benefits:
  - Virtual methods can be inlined
  - If not inlined, virtual method invocations avoid virtual table lookup
  - Faster implementation of `instanceof` and `checkcast`

Optimizing in Java 1.4.1

- Situation:
  - Large amount of native data structures in Java Heap
  - JNI transitions required to perform System operations (graphics, networking, etc.)

- Approach:
  - Remove JNI dependency by providing direct access to native memory

New I/O: Native Buffers

- Native buffers
  - java.nio.* Buffer
  - Containers for data of primitive types
- I/O operations on java.nio.ByteBuffer
  - Directly-backed buffers

```
byte abyte = 0;
ByteBuffer buf = ByteBuffer.allocateDirect(400);
for (int i=0; i<400; i++) { buf.put(abyte); }

byte abyte = 0;
MappedByteBuffer buf = MappedByteBuffer.allocateDirect(400);
for (int i=0; i<400; i++) { buf.put(abyte); }
```

New I/O: Channels

- Channels
  - java.nio.channels.* Channel
  - Allows non-blocking and interruptible operations
- Improved File System support
  - java.nio.channels.FileChannel
    - File locking
    - Memory-mapped files

New I/O: Non-blocking I/O

- java.nio.channels.SocketChannel

```
public void initializeOperations()
  throws IOException, UnknownHostException
{
    sel    = Selector.open();
    server = ServerSocketChannel.open();
    server.configureBlocking(false);
    InetSocketAddress addr =
     new InetSocketAddress(InetAddress.getLocalHost(),
                           port);
    server.socket().bind(addr);
}
```

New I/O: Non-blocking I/O

- SocketChannel Selector Model

```
public void startServer() throws IOException {
    initializeOperations();

  SelectionKey acceptKey = server.register(sel, SelectionKey.OP_ACCEPT);
    while (acceptKey.selector().select() > 0 ) {
      Iterator it = sel.selectedKeys().iterator();
        while (it.hasNext()) {
          SelectionKey key = (SelectionKey)it.next();
          it.remove();
          if (key.isAcceptable()) {
            ServerSocketChannel ssc = (ServerSocketChannel) key.channel();
            socket = (SocketChannel) ssc.accept();
            socket.configureBlocking(false);
            SelectionKey another =
              socket.register(sel, SelectionKey.OP_READ | SelectionKey.OP_WRITE);
          }
          if (key.isReadable()) { ... }
          if (key.isWritable()) { ... }
```

New I/O: Trade-offs

- New I/O is not free
  - Allocation/deallocation costs differ from Java arrays
- `get`/`put` methods of Native Buffers are not all inlined

New I/O: Trade-offs

- New I/O is not free
  - Allocation/deallocation costs differ from Java arrays
- `get`/`put` methods of Native Buffers are not all inlined
- Cost is balanced when:
  - Heavy use of System APIs with native data structures
  - Reducing Thread overhead in Server I/O

How to write Optimal Java

- Maximize inlining opportunities
  - Write small concise methods
  - Use accessor methods
  - `final` is superficial for performance tuning
  - Most JDK methods can be inlined

  - Unable to inline:
    - `synchronized`
    - Large methods
    - Methods with exception handlers

How to write Optimal Java

- Avoid object pools
  - new is inlined
  - Thread-Local allocation reduces contention
  - Precise garbage collection

How to write Optimal Java

- Avoid object pools
  - new is inlined
  - Thread-Local allocation reduces contention
  - Precise garbage collection

- Avoid programming by exception
  - Creating exception objects are expensive
  - Can prevent inlining
  - Cost only when exception is thrown

Maximizing Java Performance

Graphics

Gerard Ziemski
Java Runtime Classes
gziemski@apple.com

Introduction

- A review of Java graphics on Mac OS X
- Tips and techniques on hand tuning graphics performance of your Java applications for Mac OS X
- Demo

Past—Java Graphics on Mac OS X

- Java 1.3.1
  - Java2D hardware acceleration

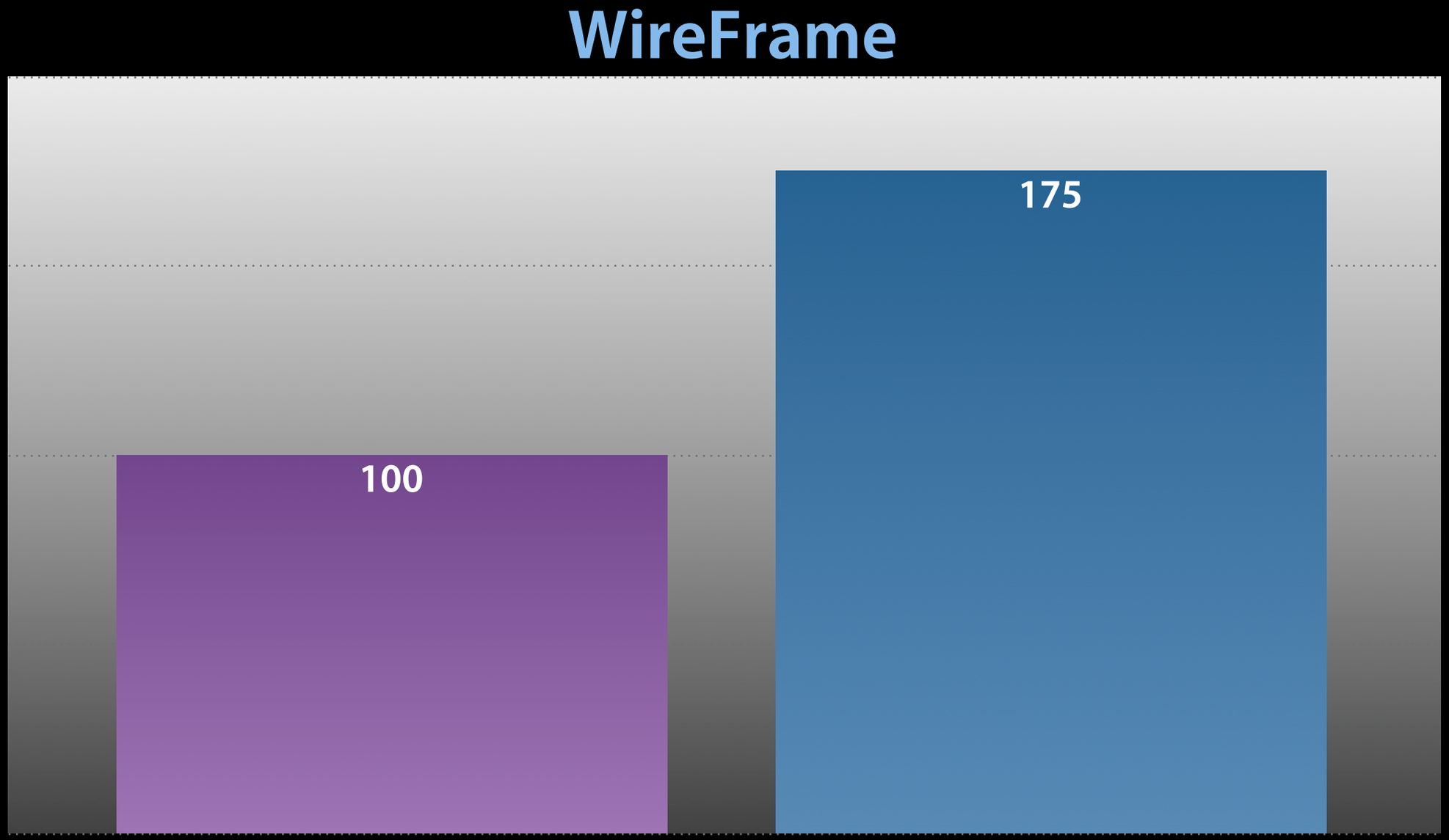
- Java 1.4.1
  - Rearchitecture from Carbon to Cocoa

Java 1.4.1 Update 1 on Mac OS X

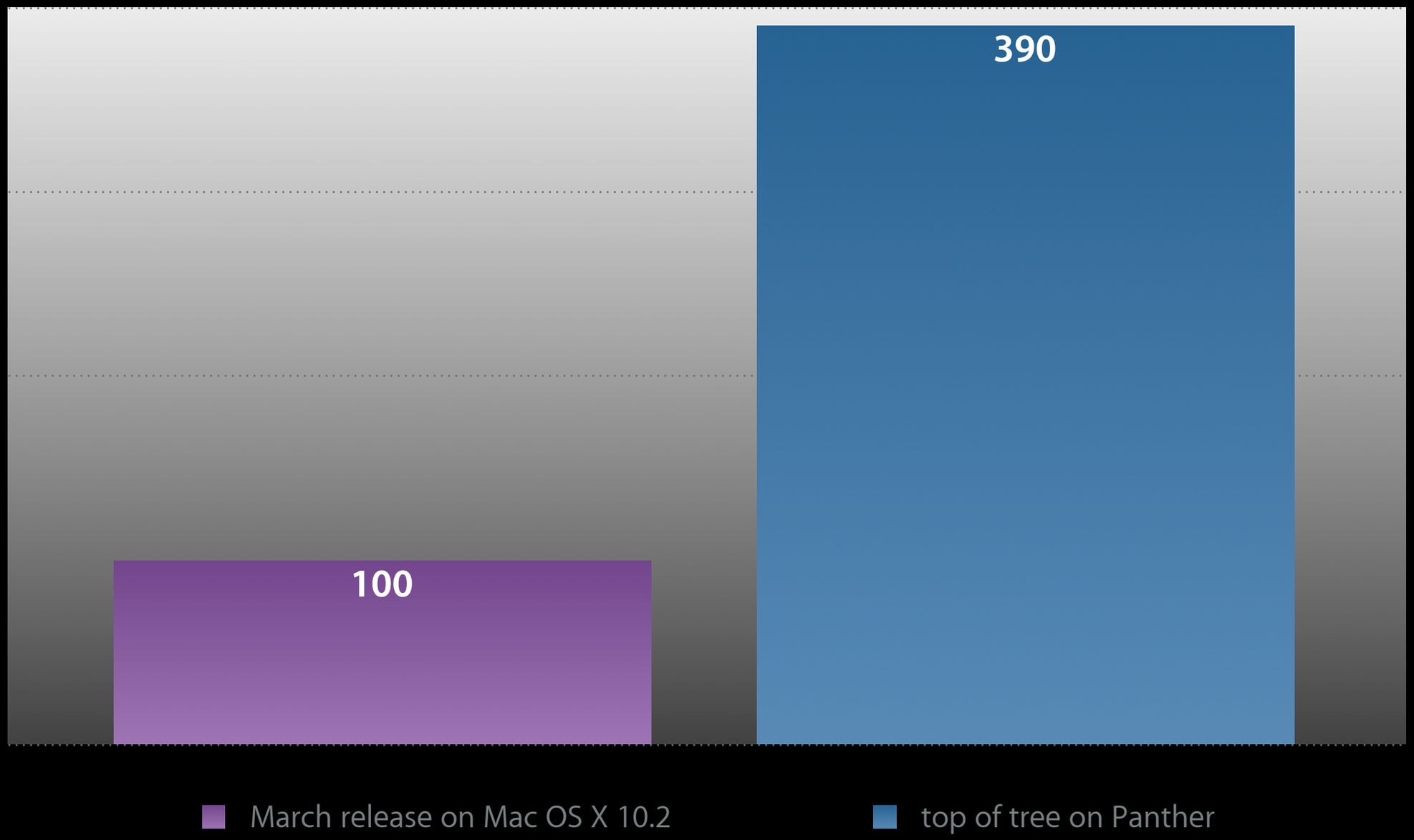
- Correctness

- Optimizations
  - Lazy drawing
  - Lazy pixel conversion
  - Lazy state management

Java 1.4.1 Graphics Benchmarks



Java 1.4.1 Graphics Benchmarks



Continuing Work

- Lazy state management
- More optimizations
- Collaboration with Sun Java2D Engineering
- Tighter integration with CoreGraphics

Image Formats

- Optimizations tips and techniques

Image Format Tips and Techniques

- Avoid hardcoding BufferedImage format types

```
BufferedImage bim = new BufferedImage(w, h, 2);

Graphics g = bim.createGraphics();
g.setColor(Color.red);
g.fillRect(0, 0, w, h);
g.dispose();
```

Image Format Tips and Techniques

- Use createCompatibleVoltileImage to create a BufferedImage

```
GraphicsEnvironment ge =
GraphicsEnvironment.getLocal GraphicsEnvironment();
GraphicsConfiguration gc =
ge.getDefaultConfiguration();
BufferedImage bim =
gc.createCompatibleVolatileImage();

Graphics g = bim.createGraphics();
g.setColor(Color.red);
g.fillRect(0, 0, w, h);
g.dispose();
```

Image Format Tips and Techniques

- In Java on Mac OS X, indexed color formats use more memory than other image formats

- The most optimal image format might vary depending on capabilities of your computer and the screen depth of your monitor

Image Format Tips and Techniques

- Natively supported image types as destination:
  - BufferedImage.TYPE_INT_RGB
  - BufferedImage.TYPE_INT_ARGB_PRE
  - BufferedImage.TYPE_USHORT_555_RGB
  - BufferedImage.TYPE_BYTE_GRAY

Image Format Tips and Techniques

- Natively supported image types as source:
  - BufferedImage.TYPE_INT_RGB
  - BufferedImage.TYPE_INT_ARGB
  - BufferedImage.TYPE_INT_ARGB_PRE
  - BufferedImage.TYPE_USHORT_555_RGB
  - BufferedImage.TYPE_BYTE_GRAY

Rendering

- Optimizations tips and techniques

Rendering Tips and Techniques

- If you need to render on a thread different than AWT event dispatch thread:
  - First, render into an image
  - Second, draw that image to the screen

Rendering Tips and Techniques

- The fastest way to draw a pixel into a natively supported image, is to write directly to the image's underlaying pixel array backing store

```
BufferedImage bim;

WritableRaster wr = bim.getRaster();
DataBuffer db = wr.getDataBuffer();
int[] pixels = db.getData();

pixels[0] = 0xff0000ff;
```

Rendering Tips and Techniques

- The fastest way to draw a pixel into a non–natively supported image, is to create a Graphics object and use it to draw into the image

```
BufferedImage bim;

Graphics g = bim.createGraphics();
g.setColor(Color.blue);
g.fillRect(0, 0, 1, 1);
```

Other

- Optimizations tips and techniques

Other Tips and Techniques

- Avoid creating new objects in your paint method
- Use simple primitives instead of shapes
- Use polyline instead of drawing lines one at a time
- Use bytes, not chars for text drawing
- Use double buffering for rendering complex scenes
- Use RuntimeOptions to help you understand your application's behavior

Demo

jogl

Ken Russell
Sun Microsystems

Wrap Up

Desktop Java Roadmap

608 Creating Great Java Applications on Mac OS X	Nob Hill Wed., 9:00am
619 Java and the Web	Nob Hill Thurs., 10:30am
620 Java Native Integration on Mac OS X	Nob Hill Thurs., 2:00pm
625 Maximizing Java Performance on Mac OS X	Russian Hill Fri., 3:30pm
708 QuickTime APIs Update	Pacific Heights Tues., 5:00pm
FF014 Feedback Session	The Marina Fri., 10:30am

Java Contacts

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Java Developer Mailing List

Java-dev

http://lists.apple.com

Reference Library

Documentation

Java Developer Documentation

http://developer.apple.com/documentation/java

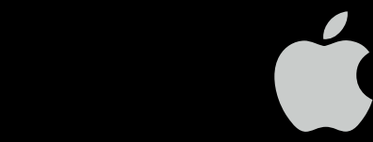
Java 1.4.1 Virtual Machine System Properties

http://developer.apple.com/documentation/java

Documentation (WWDC Private)

Java 1.4.1 System Properties

ADC Member Site > Download Software > WWDC 2003 > Mac OS X "Panther" and Xcode Prerelease Documentation



Reference Library

Other Resources

ADC Java Developer Site

http://developer.apple.com/java

Sun's Java Web Site

http://java.sun.com

Java 1.4.1 Update 1 Developer Preview

http://connect.apple.com

QuickTime for Java Seed

http://connect.apple.com

WWDC Uber Link List

http://developer.apple.com/wwdc2003/url.html

Q&A

Victor Hernandez, Jim Laskey, and Gerard Ziemski

Java Runtime Technologies and Runtime Classes

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http://developer.apple.com/wwdc2003/urls.html

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